Space Weather Technical Forecast

Issued on Friday, 27 May 2022 at 13:08 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Risk of radio blackouts now declining. Risk G1/G2 Minor to Moderate Storm intervals into start of UTC weekend.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with GOES16 recording occasional low-level C-class X-ray flares, with the background flux now declining into B-class.

There are currently five numbered sunspot regions on the Earth-facing side, with the previous largest and nominally most complex spot - Ex-AR3014 - now having crossed to the far side. In addition, AR3019 has now faded to plage in the past 24 hours. The most significant remaining spot group in terms of classification and history, AR3017, was noteworthy in the period for a significant apparent decline, with its trailing group disappearing entirely, although this may be in part due to the narrowing viewing angle. All other regions on the disc were small and simple, with no significant flares observed.

A possible (pair of) disappearing filament(s) were observed on Udaipur H-alpha imagery around 27/0600-0800UTC from the southeastern quadrant, although there was no evidence of any ejecta on coronagraphs at the time of writing. A Coronal Mass Ejection (CME) seen heading apparently westward overnight UTC has yet to be modelled, however for now, no new CMEs are considered to be en route.

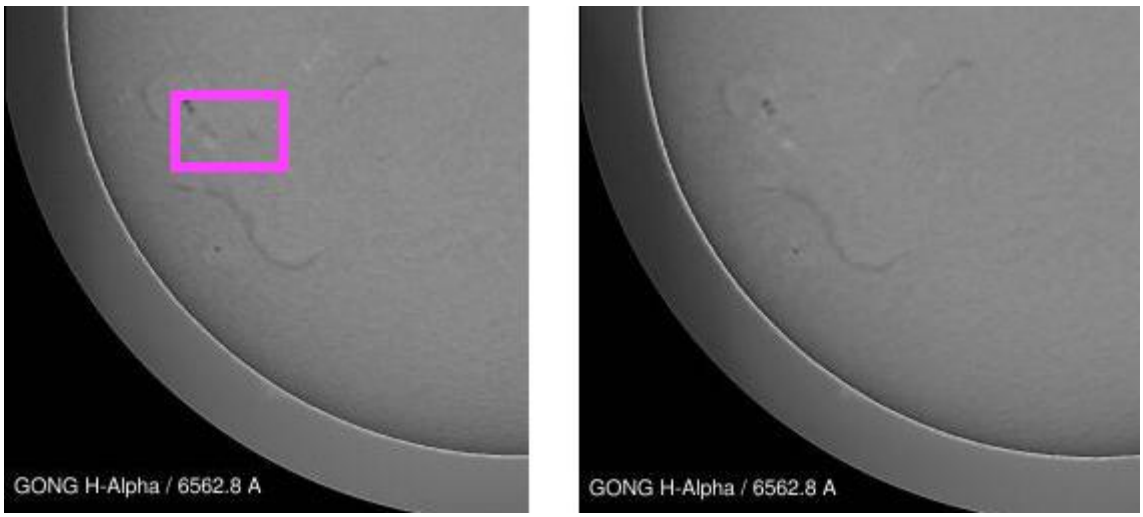

Figure 0: Udaipur H-alpha imagery from 27/0600 and 0800UTC, showing a possible (pair?) of minor filaments disappearing. There is not as yet any evidence of any ejecta having left the immediate solar environment.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, showed an enhanced pattern of behaviour in the past 24 hours in some measures, with the density in

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particular rising to a peak in excess of 40ppcc. This rise was also shown at ACE, albeit to a lesser degree, with the ACE EPAM LEMS instrument also exhibiting an enhancement. The cause of this is not definitive, however it may be either a fore-running CIR ahead of the expected imminent entry into CH84 (and/or CH85), else the leading edge of any CME enhancement from the M1.3 from Ex-3016 on 25 May. On balance, the more likely explanation is the former.

The solar wind was otherwise slow, with the speed declining from near-350km/s to 300km/s, before recovering to near 325 by the period's end. The IMF was erratic in magnitude over the period, rising to a peak of 17nT at the very end, probably in the CIR, with a north-south variation of +12/-15nT. The phi angle showed a switch in orientation around 26/1500UTC and again at 27/1030UTC, with the intervening hours mainly positive (away from the sun), but finishing on negative. An SSBC (or two) is therefore at least in part an explanation for some of the unrest in IMF seen.

The net effect of the above solar wind measures was mainly Quiet over the 24 hours, with a peak Kp of 2o in the 09-12UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) has been at Background levels through the last 24 hours.

The high energy electron flux (greater than 2 MeV) has been at Normal Background to Moderate levels, with a peak value of 776pfu at 26/1620UTC. Corresponding electron fluence remained well below the Active threshold (1e8 integrated pfu), with a slight rise to reach a plateau, with this around the level of the 2.38e7 integrated pfu observed at 27/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is now expected to be mainly Low, with AR3014 now having left the disc and AR3017 in apparent decline. The daily risk of M-class flares is now assessed as a Slight Chance. There are no obvious bright flux regions over the eastern limb at present, and any increase in activity would therefore probably need to arise from development of the current quiet front side.

Solar Wind / Geomagnetic Activity: One CME features in the current forecast, that emitted on 25 May from the M1.3 flare from Ex-3016. This may be concurrent with the fast wind from either CH84/- or CH85/-, combining to give a peak Likely G1 Saturday 28 May, perhaps G2 should the phasing of both features combine, with a Chance of arriving during the remainder of Friday 27 May.

Conditions should become less disturbed later in the UTC weekend and on into the new working week, with Monday probably seeing the most reliably Quiet conditions.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to be at Background levels during this period, with the recent daily Slight Chance now judged to be in decline as AR3014 and AR3017 rotate onto the far side in turn into the UTC weekend.

High energy electron flux (greater than 2MeV) is expected to remain near its present diurnal oscillation in the immediate term, with a probable reaction upwards in response to the high speed stream(s) of CH84/- and/or CH85/-. The risk of any exceedence of Active in the forecast should peak into the new working week (perhaps becoming Likely), with any geomagnetic activity from the intervening fast wind stream(s) and CME likely to be waning.

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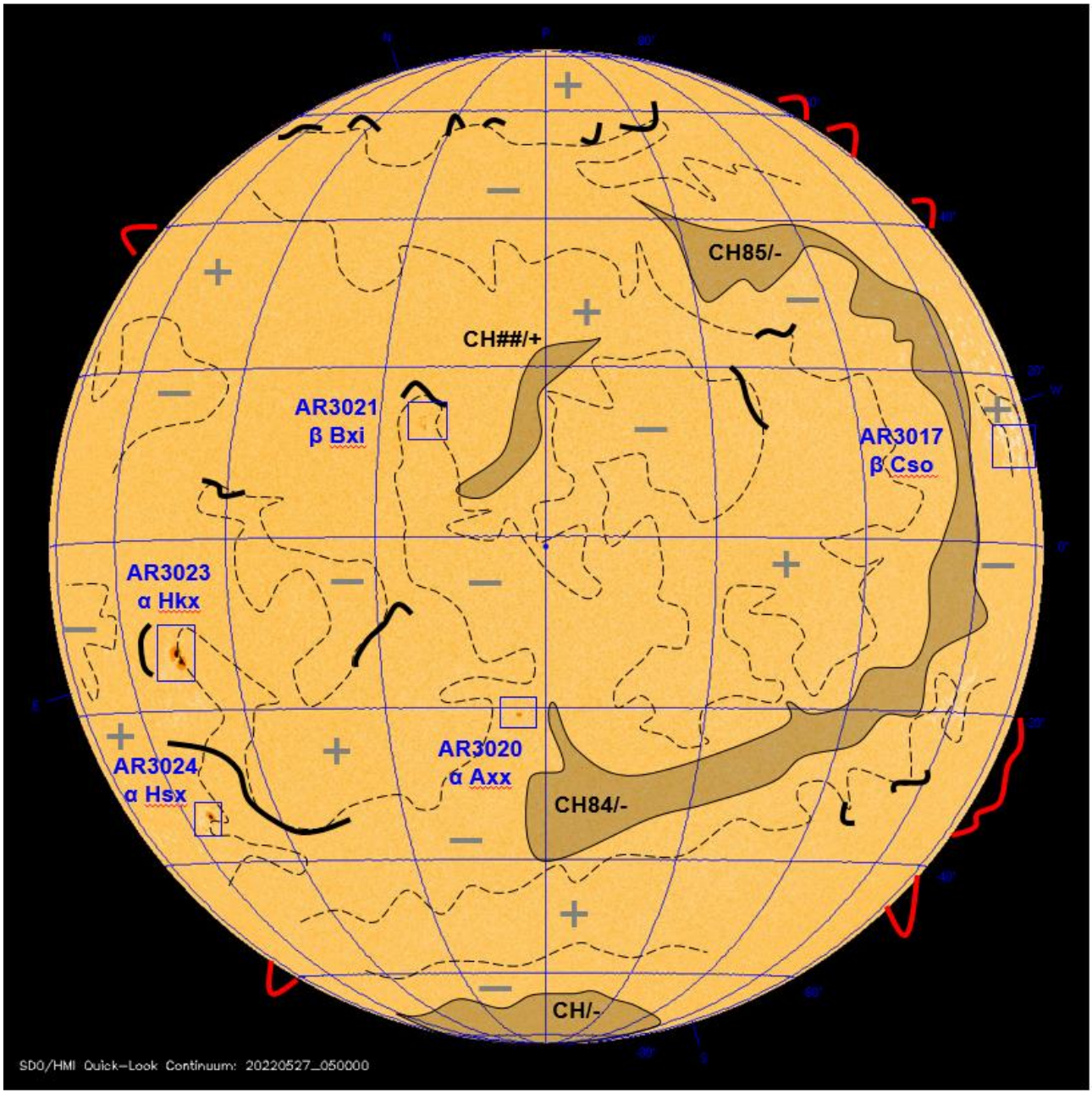
Figure 1. Solar Analysis Valid 27/0500UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

One CME features in the current forecast, that emitted on 25 May from the M1.3 flare from Ex-3016. A second candidate seen heading westwards in overnight coronagraph imagery has been determined to be far sided to no effect at Earth. A possible pair of disappearing filaments seen in Udaipur H-Alpha 27/0600-0800 have yet to materialise on coronagraphs - if indeed they ever do. Also expected in the near-term is the fast wind from one or both of coronal hole(s) CH84/- or CH85/-, with the current rising solar wind density perhaps a signature of a CIR, with the phi angle yet to transition into the required negative polarity for these features to be considered to have connected. STEREO A MAG and PLASTIC measurements are not conclusive, but perhaps suggest the analogous switch occurred at this satellite on 24 May, which would put any Earth arrival as overdue, however there may be a strong latitudinal difference in onset with CH84/85 given its unusual 'reversed C' shape.

The effects of both the CME and any fast wind influence will be greatest should they combine, with this eventuality becoming more likely as the coronal hole arrival is now nearing the most likely onset of the CME.

All considered, a peak Likely G1 Saturday 28 May may rise to perhaps give G2 should the phasing of both features combine appropriately. There is a forerunning Chance of G1 during the remainder of Friday 27 May.

Conditions should become less disturbed later in the UTC weekend and on into the new working week, with Monday probably seeing the most reliably Quiet conditions.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	60	10	1
Strong	G3	No	1	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
25/2200	Partial	Ex-AR3016	40W 20S	1010km/s	Around turn of UTC day 27 into 28 May.	Glancing blow, effects most pronounced if concurrent with CH84/85

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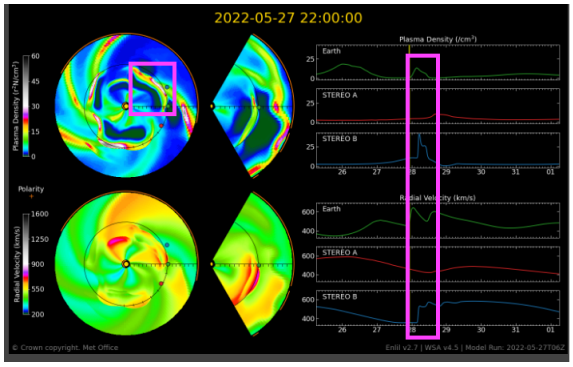
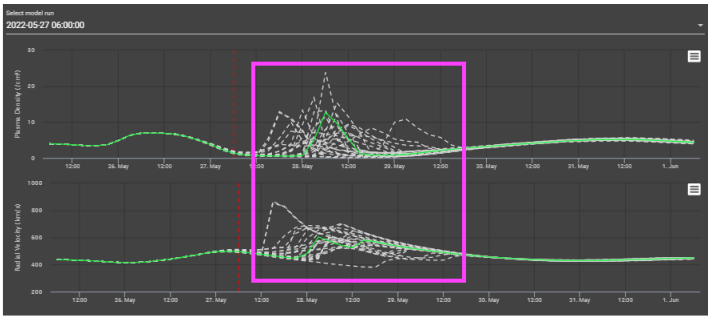
Figure 2: Latest MOSWOC Enlil model run and accompanying ensemble. Note the significant spread in arrival time and magnitude of the 25 May CME, possibly relfective of the degree of interaction with the fast wind from CH84/85. On balance arrival around the turn of the UTC day 27 into 28 May is perhaps most likely.





Radio Blackouts - X-Ray Flares:

This forecast period should see a progressive decrease in the daily chances of significant flares, with the recent AR3014 now having crossed to the far side, with its eastern neighbour AR3017 to follow suit shortly. This leaves a relatively benign Earth-facing disc comprising mainly stable and unipolar groups.

With no obvious returning regions due over the eastern limb in the coming four days, any rise in flare risk would need to be home-grown on the Earth-facing side, and the daily risk of M-class is therefore considered Slight.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	No	20	20	5	5
Very Active	**R3 to R5 X Class**	No	5	5	1	1

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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is at Background levels and is most likely to remain so through the period.

There is a slight, but now decreasing risk of increased proton flux, and solar radiation storms, as AR3014 and AR3017 rotate off the Earth-facing disc and over the east limb in turn into the UTC weekend.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	5	2	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The High energy electron flux (as measured by GOES-16) is currently at Normal Background to Moderate levels. In the immediate term, this diurnal oscillation is likely to be attenuated by geomagnetic activity from the possibly combined effects of the fast wind(s) and the 25 May CME, with geomagnetic activity probably sufficient to suppress electron counts through days one and two at least.

The chances of Active electron fluence should then increase later in the coming UTC weekend and especially into the new working week, with the magnitude of any response low confidence, but perhaps becoming Likely to pass Active by Monday 30 May.

MOSWOC REFM's forecast is currently running counter to the expected evolution, perhaps because its 72-hour range is insufficient to ee the expected eventual rise in fluence materialise. Persistence is offering a better guide in this respect, although the fact that the coronal holes differ between rotations and the fact there is a CME expected should mean that details differ.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	40	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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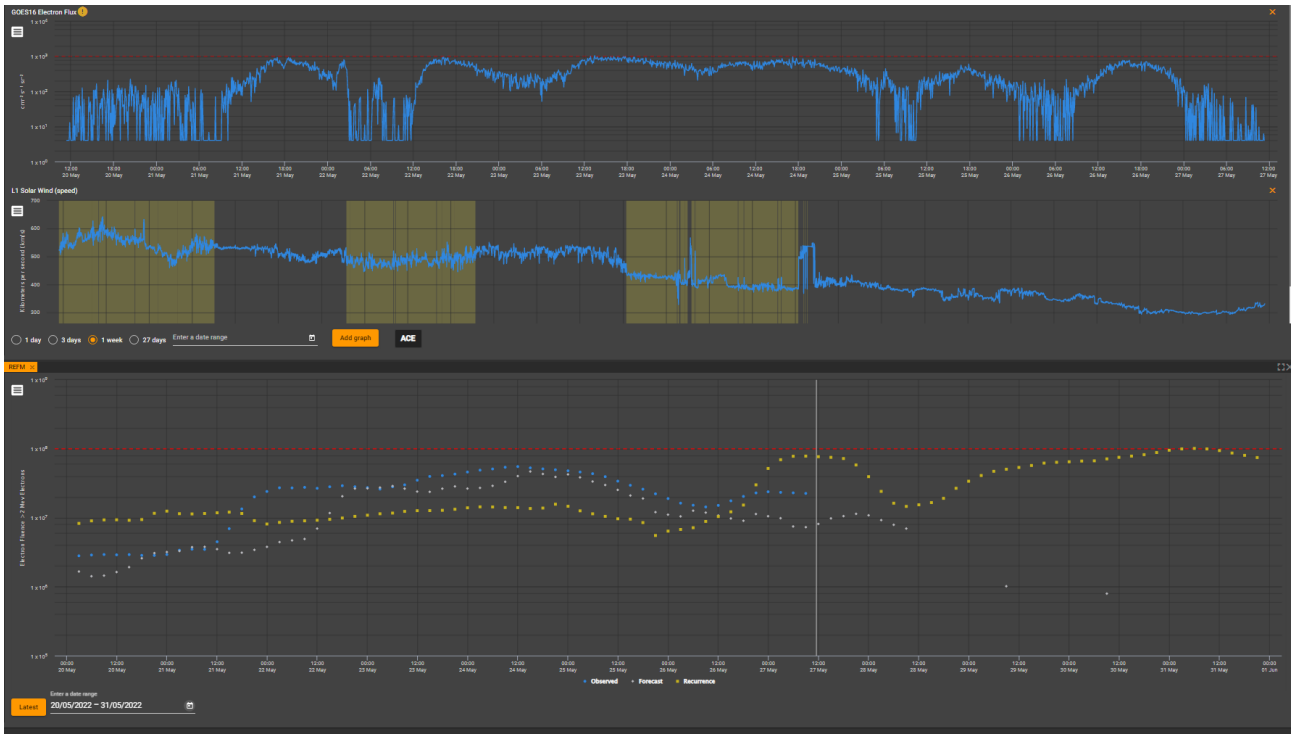
Figure 3: Past week in high energy electrons at GOES 16 (top), showing response to L1 solar wind (middle, DSCOVR and yellow-shaded ACE). Observed 24-hour fluence for the same period can be seen in the REFM-containing plot (bottom), with persistence felt to be a much better guide than the REFM foecast, perhaps because it is curtailed at 72 hours' range, before any eventual upturn.



NOTE: Our REFM model has been upgraded and has changed in appearance. The two main changes are the option to include a recurrence graph, which traces what happened on during last solar rotation for comparison and potential expectation in the coming 3 days (each plot is the observation from T-minus 28 days). Also, the cadence of REFM forecast fluence data is reduced past day 1 to only one value per day. The cadence remains 3-hourly for the first 24 hours.

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